

THE PHENOLOGY OF THE PLANT BUGS (HEMIPTERA: MIRIDAE)
ASSOCIATED WITH *CEANOTHUS CRASSIFOLIUS* IN A
CHAPARRAL COMMUNITY OF SOUTHERN CALIFORNIA

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Abstract.—Seven species of Miridae were found to develop on *Ceanothus crassifolius* at a locality in southern California. Mirid activity was confined to the first five months of the year, the period of lowest temperatures and greatest precipitation, and also the time of blooming and fruiting for *C. crassifolius*. Although levels of synchrony are high, the periods of greatest abundance of mirid species are spread out through the growing season.

There are little data on the host relationships of western U.S. Miridae. A relatively recent list of associations (Knight, 1968) does not suggest a large fauna on *Ceanothus*. However, I have found that species of *Ceanothus* and other Rhamnaceae serve as hosts for a variety of plant bugs in California. This paper deals with the species on *C. crassifolius* Torrey, or Hoaryleaf Ceanothus, an evergreen shrub common between 450-1100 m in the dry chaparral covered hills of southern California.

The study is based on collections of all instars of Miridae on *C. crassifolius* at a single site throughout most of 1979. Primary objectives were to determine the number of species developing on this plant, their occurrence relative to host phenology, and the degree of interspecific seasonal overlap. Preliminary data of feeding behavior are also presented.

Seven species were found to develop on *C. crassifolius*. Six belong to the Phylini and one to the Mirini. Identification to species is possible for only five of the seven at this time. The phylines collected were *Psallus ancorifer* (Fieber), *Psallus breviceps* Reuter, *Psallus* sp., *Microphylellus bicinctus* (Van Duzee), *Lepidopsallus californicus* Van Duzee, and *Phymatopsallus* sp. near *croceguttatus* Knight. The single mirine present was *Pycnocoris ursinus* Van Duzee. In addition, five adults of *Deraeocoris fulgidus* (Van Duzee) were collected. Since this species was not represented by immatures it is not dealt with further.

SITE DESCRIPTION AND METHODS

The sampling site is located in the hills to the immediate west of Menifee Valley, an inland southern California valley ca. 5 km east of Lake Elsinore in SW Riverside Co. Since the phenology of *C. crassifolius* varies with microhabitat, collections were restricted to an area of .44 hectare atop a north-south running ridge (33°39'N, 117°13'W; 550 m elev.). This relatively small area limited the number of plants, but minimized variation in exposure, drainage and elevation. All samples were from plants judged to be in approximately the same phenological state.

Considering the high level of flight activity in plant bugs (Southwood, 1960), movement of adults to the study area from plants in more advanced phenological states is a confounding variable. However, the effect of adult dispersal was probably minimized by choice of the study site where the host plants were all in a similar stage of development. The site was also situated ca. 0.50 km from locales with plants that were obviously disjunct phenologically. Furthermore, the lack of seasonally disjunct adults during sampling suggests that intersite movement was minimal.

The study area is dominated by chaparral but is distinctly influenced by Coastal Sage Scrub vegetation (see Munz, 1959, for a characterization of these communities). As is typical of the low hills bordering the hot, dry interior valleys of southern California, perennial vegetation on the site is relatively sparse. Only ca. 50% of the surface is covered by perennial canopy. The remainder is bare ground, much of it strewn with large granitic boulders. Annual grasses and herbs cover much of the surface in winter and spring. Dominant perennials are *Salvia mellifera* Greene (Labiatae), *Eriogonum fasciculatum* Bentham (Polygonaceae), and *Adenostema fasciculatum* Hooker and Arnott (Rosaceae). *Ceanothus crassifolius* itself has a patchy distribution and contributes only ca. 5% to the total perennial canopy (E. M. Fisher, personal communication).

Seven relatively large *C. crassifolius* of 2–3 m height were sampled from 21 January to 1 December 1979. Immatures of the season's first mirid species were already present when collections began. Mirid activity continued from that time until 4 July. The sampling dates during this time are given in Figs. 1 and 2. A mean of 6.3 days (range, 4–13) intervened between consecutive collections. On only one occasion (20 June–4 July) did the number of intervening days exceed 8. Samples after 10 July were made twice monthly. This was the first date after 21 January that sampling failed to collect mirids.

Plant bugs were collected by beating vegetation and allowing specimens to fall into a modified sweep net, 12 cm deep and 28 cm in diameter. Three positions at 1–1.5 m height were sampled on each plant. Plant bugs were quickly aspirated at each position. After all plants were sampled, the entire catch was killed in cyanide. Immatures were then transferred immediately

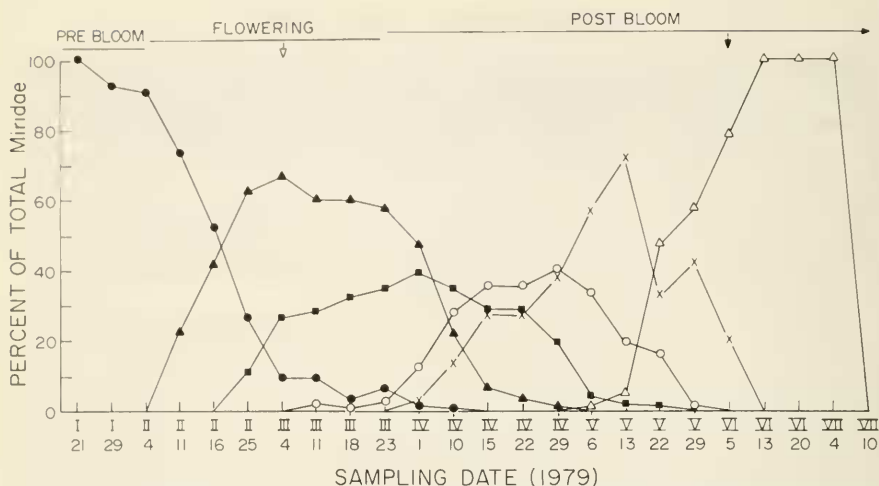


Fig. 1. Phenology of Miridae and host (*Ceanothus crassifolius*) during 1979. Adults and immatures combined for each plant bug species. ● = *Psallus ancorifer*; ▲ = *Psallus breviceps*; ■ = *Psallus* sp.; ○ = *Microphylellus bicinctus*; × = *Lepidopsallus californicus*; △ = *Phymatopsallus* nr. *croceguttatus*. *Pycnocoris ursinus* omitted (see Fig. 2). Summary of host phenology indicated at top. Open arrow indicates day of maximum bloom; closed arrow indicates time of fruit dehiscence.

to 70% alcohol for storage. Most of the adults were point mounted, the remainder were kept in alcohol. All collections were made during daylight, from 0900–1200 hours.

Mirid immatures and adults were readily associated by structural and color traits common to both. Rearings of six of the species verified these associations. *Psallus ancorifer* was the only species not reared. Three to ten nymphs of each species were reared by placing them with fresh vegetation in a covered Petri dish (100 × 10 mm). Plant material was replaced every other day. Specimens in rearing were also utilized for feeding observations. Bugs were provided leaves, fruit and stems. Flowers were also made available to species active early in the season.

Rainfall and mean monthly temperatures were recorded from August 1978–July 1979 (Fig. 3). Precipitation was monitored at the study site. Temperatures are from published U.S. Weather Bureau records from Sun City, Calif., ca. 3.5 km from the site (433 m elev.). The periodicity of rainfall during and immediately before this study was normal for southern California, i.e., winter concentrated. The total amount of precipitation (435 mm), however, was ca. 65% above normal.

Voucher specimens from this study are deposited in the collections of the Department of Entomology, University of California, Riverside, and the National Museum of Natural History, Washington, D.C.

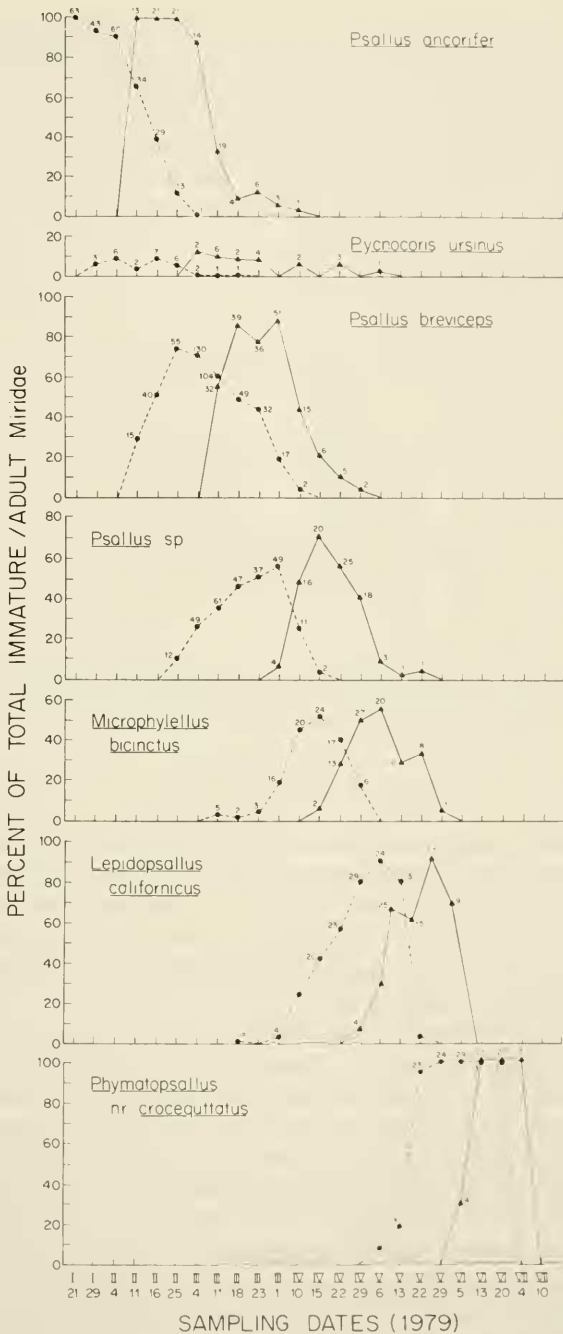


Fig. 2. Phenology of the seven species of Miridae on *Ceanothus crassifolius* during 1979. Dotted lines indicate immatures, solid lines adults.

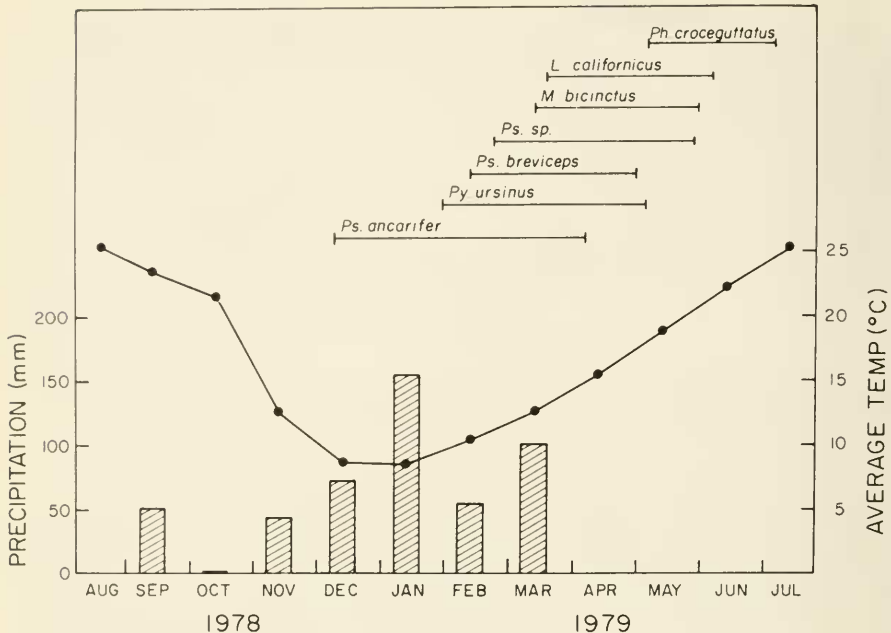


Fig. 3. Occurrence of the Miridae on *Ceanothus crassifolius* relative to monthly precipitation (bars) and average monthly temperature (connected dots) during 1978–79. December occurrence of *P. ancorifer* assumed from collections in 1980.

RESULTS AND DISCUSSION

The results of sampling are given in Figs. 1 and 2. Figure 1 indicates the percentage of all stages of each species relative to the total number of Miridae collected per sampling day. Figure 2 considers the immatures and adults of each species separately as a percentage of total immature, and adult catch, respectively, per sampling day. The latter also includes the total number of individuals collected daily.

All seven species are packed into the first six months of the year. The only mirids collected from 4 July–December were a few adults of various species assumed to be strays from plants other than *C. crassifolius*. The activity period for each species varied from two to three months. There is no evidence for more than a single generation per year for any of the species. Since first-instars of all species were collected prior to successive instars, it is assumed that the summer and autumn are spent in the egg stage.

Although there was substantial synchrony, none of the species overlap completely (Fig. 2). Instead, they follow one another closely throughout the season. Sampling revealed the following order of appearance for phyline species: *Psallus ancorifer*, *Psallus breviceps*, *Psallus sp.*, *Microphyllellus*

bicinctus, *Lepidopsallus californicus*, and *Phymatopsallus* near *crocegut-tatus*. The mirine, *Pycnocoris ursinus*, was too uncommon to determine confidently its order of appearance relative to *P. ancorifer* and *P. breviceps*. The pattern of species occurrence shown here is similar to that reported by Waloff (1968) for the mirids on Scotch broom in England.

Figure 1, containing all instars, shows that each of the six phylines represented the dominant species at some time during the sampling period. Only the two earliest (*P. ancorifer* and *P. breviceps*) and latest species (*L. californicus* and *Ph. nr. crocegut-tatus*) were dominant in the absolute sense in representing over 50% of the total mirid catch on any given sampling day. However, the immatures and adults of all six species did so dominate at some time when compared to heterospecific immatures and adults, respectively (Fig. 2).

The appearance of *P. ancorifer*, the season's first species, is not resolved (Fig. 2). It was not yet present when plants were checked in early December 1978. Additional sampling was not possible until 21 January 1979 at which time *P. ancorifer* immatures were in abundance. To better determine the appearance of this species, host plants were checked weekly during the last two months of 1980. In that year, first-instars were first collected on 7 December.

The occurrence of species relative to host phenology is summarized in Fig. 1. The flowering period for *C. crassifolius* is from January to April (Munz, 1959). At the collecting site sampled plants flowered from 4 February to 23 March. *Psallus ancorifer* was the only species active prior to bloom. The appearance of *P. breviceps* was roughly concurrent with the onset of flowering. *Psallus* sp., *M. bicinctus* and *L. californicus* first appeared during flowering but most of their activity was postbloom. The last species, *Ph. nr. crocegut-tatus*, did not appear until well after flowering was complete, and, in fact, was most abundant after fruit dehiscence. Although the largest number of species were active during fruiting, species present during flowering were more abundant. Thus, 936 mirids ($\bar{x} = 133.7/\text{day}$) were collected on the seven sampling dates during flowering whereas only 647 ($\bar{x} = 92.4$) were taken on the seven dates immediately after bloom.

Although sampling frequency was not designed to detect seasonal variation in sex ratios, such variation was apparent in *P. breviceps*, *Psallus* sp., *M. bicinctus*, and *L. californicus*. Populations of all four were male-biased at the beginning of adult activity and female-biased toward the end. In *P. breviceps*, for example, collections on 11 and 18 March with 45 males and 26 females deviated significantly from a 1:1 ratio ($P < .05$) as did samples on 23 March and 1 April with 18 males and 58 females ($P < .005$).

Five of the seven mirids on *Ceanothus crassifolius* were observed feeding in the laboratory. Ultimate instar nymphs of *Psallus* sp., *Psallus breviceps*, *Microphylellus bicinctus*, and *Phymatopsallus* nr. *crocegut-tatus* were com-

monly observed to insert their proboscis in the underside of leaves. Since this surface is covered with a woolly pubescence the actual points of insertion relative to leaf venation were not observed. Fruit, stems and the upper surface of leaves were ignored by these species. Flowers were available only to *Microphylellus bicinctus* and *Psallus* sp. The latter fed on floral parts but appeared to prefer leaves. The former was observed feeding on leaves only. Feeding in a single adult of *Pyncnocoris ursinus* was observed intermittently over a period of several days. It fed on fruit and ignored all other vegetative parts provided. Flowers, however, were not available to this species when observations were made.

The occurrence of several related species on the same host plant is of evolutionary and ecological interest. This is especially so if the species occur at the same time. Estimates of interspecific seasonal overlap are given in Table 1. Data are presented for the entire activity period of each species as well as for the period of adult activity. The degree of seasonal overlap for species pairs is reported as a percentage of the number of sampling dates synchrony was confirmed, relative to the total number of sampling days each species occurred. Indices of synchrony, summarizing degree of seasonal overlap for each species, were also calculated (Table 1).

Seasonal overlap of the seven species is considerable (Table 1). As expected from Fig. 1, it is least for the first (*P. ancorifer*) and last (*Ph. nr. croceoguttatus*) species and greatest for intermediates (*P. breviceps*, *P. sp.*, and *M. bicinctus*).

The degree of synchrony among congeners is of particular interest. Although three of the species are currently placed in *Psallus*, it is clear that *P. breviceps* is closest to *M. bicinctus*. It keys to *Microphylellus* and, according to T. J. Henry (personal communication), it is closer to that genus than to *Psallus*. The only other congeners are *Psallus ancorifer* and *Psallus* sp. Both species pairs show considerable synchrony (Figs. 1, 2; Table 1). However, in each case the overlap is primarily between immatures of one and adults of its relative. This suggests that the potential for interspecific sexual interaction, at least, is minimal. Possible modes of additional separation, such as oviposition sites have not been adequately studied. Waloff (1968) and Dempster (1964) reported some differences in the feeding habits of *Orthotylus* species occurring together on Scotch broom. This had been predicted earlier by Waloff and Southwood (1960) upon noting contrasting rostral lengths among the different species. A similar anatomical difference does not occur between congeners on *C. crassifolius*. Preliminary observation of feeding behavior in nymphs of *P. breviceps* and *M. bicinctus* does not suggest different feeding sites. Both feed commonly on the underside of leaves (see above).

The plant bugs on *C. crassifolius* occur during the coolest time of year and during or directly after months of maximum precipitation (Fig. 3). This

Table 1. Synchronic relationships of the Miridae on *Ceanothus crassifolius*.

Species	Degree of Seasonal Overlap ^{ab}							No. Synchronic Relationships	Index of Synchrony ^c
	<i>ancorifer</i>	<i>ursinus</i>	<i>breviceps</i>	sp.	<i>bicinctus</i>	<i>californicus</i>	<i>croceguttatus</i>		
<i>P. ancorifer</i>	X	69	56	44	31	25	0	5	37.5
		67	55	22	0	0	0	3	24.0
<i>Py. ursinus</i>	73	X	80	80	60	53	7	6	58.8
	60		80	60	40	23	0	6	43.3
<i>P. breviceps</i>	75	100	X	83	67	58	0	5	63.8
	63	100		63	38	13	0	5	46.2
<i>P. sp.</i>	54	92	77	X	85	77	23	6	68.0
	25	62	63		75	50	0	5	45.8
<i>M. bicinctus</i>	42	75	67	92	X	83	33	6	65.3
	0	51	43	86		71	0	4	41.8
<i>L. californicus</i>	33	67	58	83	83	X	42	6	61.0
	0	33	17	67	83		16	5	36.0
<i>Ph. nr. croceguttatus</i>	0	12	0	38	50	63	X	4	27.2
	0	0	0	0	0	25		1	4.2

^a Degree to which species X (horizontal) is overlapped seasonally by species Y (vertical) determined by dividing the number of days both were collected together by the total number of days X was collected multiplied by 100.

^b Figures above horizontal lines in body of table refer to overlap regardless of instar; those below horizontal line refer to adult overlap only.

^c Index of synchrony for a given species determined by adding individual scores and dividing by 6, the maximum number of synchronic interactions.

is the time of maximum growth and flowering for most chaparral plants. *C. crassifolius* is among the first plants to bloom in the chaparral and its associated mirids are the first of the season to occur. *C. crassifolius* commonly begins to bloom in January, two months or so before the other dominant perennials, and before the appearance of most annuals.

The degree of host specificity for the mirids collected here is unknown, nor is it possible to profitably use species distribution data as a means of speculation since the taxonomy and biology of the species are so poorly known. In any case, near the study site, adults of *M. bicinctus* have been taken in low numbers from *Quercus agrifolia* Neé, and a series of *P. breviceps* was collected from *Rhamnus crocea* Nuttall. Both plants are relatively uncommon at or near the sampling site. The type series of *M. bicinctus* was collected from an unidentified *Ceanothus* (Van Duzee, 1914). *Psallus ancorifer*, a supposedly widespread species, was recorded from "clover" by Knight (1927) and onions by Thompson (1945). *Lepidopsallus californicus* is known from southern California and Fresno, Calif. The latter locale is out of the range of *C. crassifolius* but is close to areas harboring congeners.

Pycnocoris ursinus, so far, has been taken only on *Ceanothus*. I have collected it on at least three species of *Ceanothus*, and two specimens in the P. H. Timberlake collection (UC Riverside) were collected in Ensenada, Baja California on *Ceanothus verrucosus* Nuttall.

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